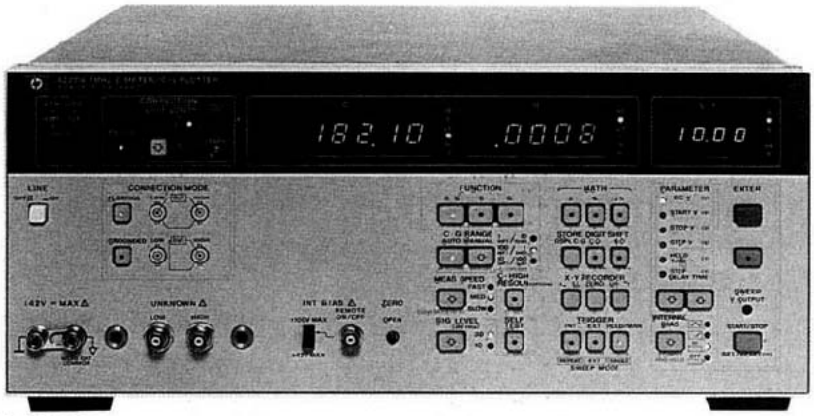
SEMICONDUCTOR TEST EQUIPMENT

1 MHz C Meter/C-V Plotter

HP 4280A

- Built-in sweepable dc bias source and timer for C-V (capacitance-voltage)/C-t (capacitance-time) measurements
- High-speed C-t measurements with minimum measurement interval of 10 ms (10 μs if an external pulse generator is used)
- Basic C measurement accuracy: 0.1%
- Test lead extension up to 5 m
- 51/2-digit display resolution (option) for C measurement



HP 4280A

HP 4280A MHz C Meter/C-V Plotter

The HP 4280A 1 MHz C Meter/C-V Plotter measures the capacitance and conductance of semiconductor devices and materials as functions of applied voltage (C-V) or time (C-t). The HP 4280A consists of a precision 1 MHz C-G meter, a programmable dc bias source that can be swept in staircase fashion, and accurate timing control.

C-V and C-t Measurements

The HP 4280's internal dc bias source has a range of 0 V to ±100 V with 1 mV resolution on the most sensitive range. Various measurement parameters for C-V and C-t measurements—hold time (bias pulse width) and delay time (measurement interval)—can be manually set from the front panel, or these parameters can be set under program control via the HP-IB. Settable range for C-t measurement interval is 10 ms to 32 s with a best-case resolution of 10 μs. If an external pulse generator is used, however, measurement intervals as short as 10 μs can be set. Up to 9,999 readings can be set for a C-t measurement. These capabilities make it possible for the HP 4280A to measure the C-t characteristics of virtually any device.

High-Speed C-t Measurement

The HP 4280A has a special sampling integration technique for measurement intervals as short as 10 μs using an external pulse generator, such as the HP 8112A or 8160A, to provide the bias pulse. Short measurement interval makes the HP 4280A applicable to deep-level transient spectroscopy (DLTS) measurements, commonly used to analyze physical characteristics of semiconductors.

Precision, High-Resolution Measurements

The HP 4280A measures capacitances up to 1.900 nF, over 3 ranges, with 0.001 pF resolution on the most sensitive range. Conductance up to 12 mS can be measured with 10 μS maximum resolution.

C and G measurements are made at 1 MHz. AC signal level is selectable between 10 mV rms or 30 mV rms, suitable for semiconductor measurements. Basic measurement accuracy is 0.1%. Maximum display resolution is 4½ digits. With Option 001, however, display resolution for capacitance is 5½ digits.

The accuracy and resolution of the HP 4280A satisfy the stringent requirements of laboratory and research and development measurements, which require the detection of minute changes in device characteristics.

Probed Measurements on Wafers

The HP 4280A has an automatic error-correction function that makes it possible to use test leads up to 5 m long (HP P/N (8120-4195). The HP 4280A can measure either floating or grounded devices. Thus, it can be connected to a wafer prober and still provide stable, accurate C and G measurements.

Easy, Low-Cost Systemization

HP-IB is standard on the HP 4280A, so a process evaluation system or a lab automation system capable of evaluating the physical characteristics of semiconductor devices can easily be constructed.

The HP 4280A is equipped with analog outputs to allow users to plot device characteristics on an X-Y recorder or large-screen display.

Specifications (see data sheet for complete specifications)

Measurement functions: C, C-V and C-t

Function		Available Internal DC Bias Function
Basic Function	Selection	
C	C only, G only C-G only	Off ⎓ (dc)
C-V	C-V G-V C & G-V	⎍ ⎍
C-t	C-t G-t C & G-t	⎍ ⎓ (dc), Off

C Measurement

Test signal

Frequency: 1 MHz ±0.01%.
OSC level: 30 mV rms or 10 mV rms ±10%.
Measurement terminals: 2-terminal-pair configuration (High, Low, and Guard).
Connection mode: Sets connection configuration between DUT (floating/grounded) and measurement circuit.
Ranging: Auto or manual.
Error compensation

Cable length: 0 m, 1 m or 0 to 5 m. The standard cable (HP P/N 8120-4195) up to 5 m can be internally compensated.
Zero open: Compensate stray capacitance and conductance at the test fixture.
External error compensation: Compensate errors by external computer to eliminate other error factors not listed above.
Measurement speed: Fast, Med, or Slow.
Trigger: Internal, External or Hold/Manual.
Internal dc bias mode: Off or ⎓ (dc).

Measurement Range/Resolution/Accuracy

Range[1]	Resolution[2]	Max. Display[3]	Accuracy[4] ±(% of rdg + counts) OSC: 30 mV	OSC: 10 mV
10 pF/100 μ S	0.001 pF 0.01 μS	19.000 pF 120.00 μS	± (0.1% + 5) ± (0.2% + 5)	± (0.2% + 5) ± (0.3% + 5)
100 pF/1 mS	0.01 pF 0.1 μS	190.00 pF 1.2000 mS	± (0.1% + 3) ± (0.2% + 3)	± (0.2% + 3) ± (0.3% + 3)
1 nF/10 mS[5]	0.1 pF 0.001 mS	1.9000 nF 12.000 mS	± (0.1% + 3) ± (1.2% + 3)	± (0.2% + 3) ± (1.2% + 3)

[1] 100 pF/1 mS and 1 nF/10 mS ranges only in grounded measurement.
[2] When measurement speed is set to Fast (10 mV/30 mV) or Med (10 mV), resolution and max. display become 1 digit less (3½-digit display).
[3] Approx. 50 pF at 100 pF/1 mS range and 1.76 nF at 1 nF/10 mS range in grounded measurement. Error correction to offset residuals will reduce maximum value that can be measured.
[4] Accuracy is specified at unknown terminals and at the end of HP 16082A test leads (1 m) after warm up ≥30 min., at temperature 23° C ±5° C, zero open calibration is performed, and correction is enabled. Front panel settings are C-G, floating, and 0 m or 1 m (cable length). Some errors will be added at other settings (see data sheet). C accuracy is specified when D < 0.05 and G accuracy is specified when counts of C < 1/100 of range. Error double at 0° to 55° C.
[5] Add 0.1% of rdg for C and 0.2% of rdg for G when HP 16082A is used.

C-V Measurement

Function: Measures C-V, G-V, or C and G-V characteristics using internal staircase bias.
Measurement speed: Fast, Med, or Slow

C-t Measurement

Function: Measures C-t, G-t or C and G-t characteristics using internal and/or external pulse bias source.
Internal measurement mode: Burst or sampling mode automatically selected.
Burst mode: Apply 1 pulse, then make repetitive measurement with specified time interval between measurements.
Sampling mode: Repeated pulse with single samples between pulses. Delay between application of measure voltage and sample can be specified.
Measurement speed: Fast or Med

DC Bias Source

Output mode: ⎍, ⎍, ⎍ ⎓ (dc) or Off
Output voltage range/resolution/accuracy

Voltage Range	Resolution	Accuracy* ±(% of setting + volts)
±1.999 V	1 mV	± (0.2% + 0.01 V)
±19.99 V	10 mV	± (0.1% + 0.02 V)
±100.0 V	100 mV	± (0.1% + 0.1 V)
*at 23° C ±5° C, at 0° C to 55° C error doubles.		

Staircase sweep parameter settings (C-V basic function only)
Start/stop voltage: 0 V to ±100 V (max. 1 mV resolution)
Step voltage: 0 v to 200 V (max. 1 mV resolution)
Hold/step delay time (th/td): 3 ms to 650s (max. 1 ms resolution)
Pulse Bias Parameter Settings (C-t basic function only)
DC/pulse/measurement voltage: 0 V to ±100 V (max. 1 mV resolution)
Number of readings: 1 to 9,999
Hold time (th): Max 10 μs resolution
Internal bias: 10 ms to 32 s
Ext bias slow: 50 μs to 32 s
Ext bias fast: 10 μs to 32 s
Delay time (td): 10 μs to 32 s (max 10 μs resolution)
Burst mode

Function	Meas. Speed	Block Mode	Non-Block Mode Data Format Binary	ASCII
C-t	Fast	10 ms to 32 s	20 ms to 32 s	150 ms to 32 s
G-t	Med	50 ms to 32 s		200 ms to 32 s
C and G-t	Fast			
	Med	100 ms to 32 s		250 ms to 32 s

Sampling Mode
Ext bias slow: 200 μs to 5 s
Ext bias fast: 10 μs to 5 s
Math functions: Displays measured C/G values as differential values (Δ), % ratio (%), or differential % (Δ%) of the reference value.

Other

HP-IB: Not just IEEE-488, but the hardware, documentation, and support that delivers the shortest path to a measurement system.
Data output format: ASCII or binary
Block mode output: Can make C-V/t characteristics measurement and store measured data (C-V/t or G-V/t function: 680 data; C & G-V/t function: 400 data) into the internal data buffer. Then packed data can be output.
Recorder output
Output voltage: ±10 V for C, G, and V/t data
Accuracy: ±(% of output voltage + V)
C or G: ±(0.5% + 20 mV)
V or t: ±(0.15% + 40 mV)
Self-test: Verifies normal measurement operations (not including calibration).

Options

Opt 001: High-Resolution Offset Capacitance Measurement
Function: Increases C measurement resolutions by 1 digit with offset reference value.
C offset range: 0 to 1023 pF (1 pF increment). C offset value can be set by measured data or numeric key.

General Specifications

Operating temperature range: 0° to 55° C; 95% RH at 40° C
Power: 100/120/220 V, ±10%; 240 V, + 5% − 10%; 48 to 66 Hz, 140 VA max
Dimensions: 426 mm W × 177 mm H × 498 mm D (16.5 in × 7 in × 19.5 in)
Weight: 15.3 kg (33.7 lb)

Accessories Furnished

HP 16080A: Direct Coupled Test Fixture

Reference Data

Measurement Time

Meas. Speed	Measurement Function C-G		C		G	
Fast	30	(70)	10	(30)	10	(30)
Med	70	(110)	40	(60)	35	(55)
Slow	400	(440)	270	(290)	220	(240)

When measured values are displayed on the front panel and the recorder outputs are used, measurement times in parentheses apply.

Residual L-R compensation: Error compensation for residual L-R (max. 19 μH/190 Ω) is available using an external controller.
Internal DC Characteristics of High and Low Unknown Terminals (without DC bias)
Maximum offset voltage: ±1 mV
Maximum allowable current: 100 mA
Internal DC Bias
Settling time (99.9% of final value): 0.05 × voltage swing (V) + 1.7 (ms)
Maximum output current: ±6 mA
Hold time/step delay time/th/td: 0.02% (basic accuracy)
Response time of the EXT SLOW bias circuit (99.9% of final value): 100 μs
Opt 001
C offset accuracy: ±(2% of reference value +0.5 pF) can be compensated by CORRECTION ENABLE key.

Ordering Information

	Price
HP 16081A Test Leads, 2 m, Double-Shielded, BNC	$760
HP 16082A Test Leads, 1 m, BNC	$260
HP 16083A Pulse Bias Noise Clipper	$415
HP 4280A 1 MHz C Meter/C-V Plotter	$12,200
Opt 001 C High Resolution (not field-installable)	$470
Opt W30 Extended Repair Service (see page 671.)	

☎ For off-the-shelf shipment, call 800-452-4844.